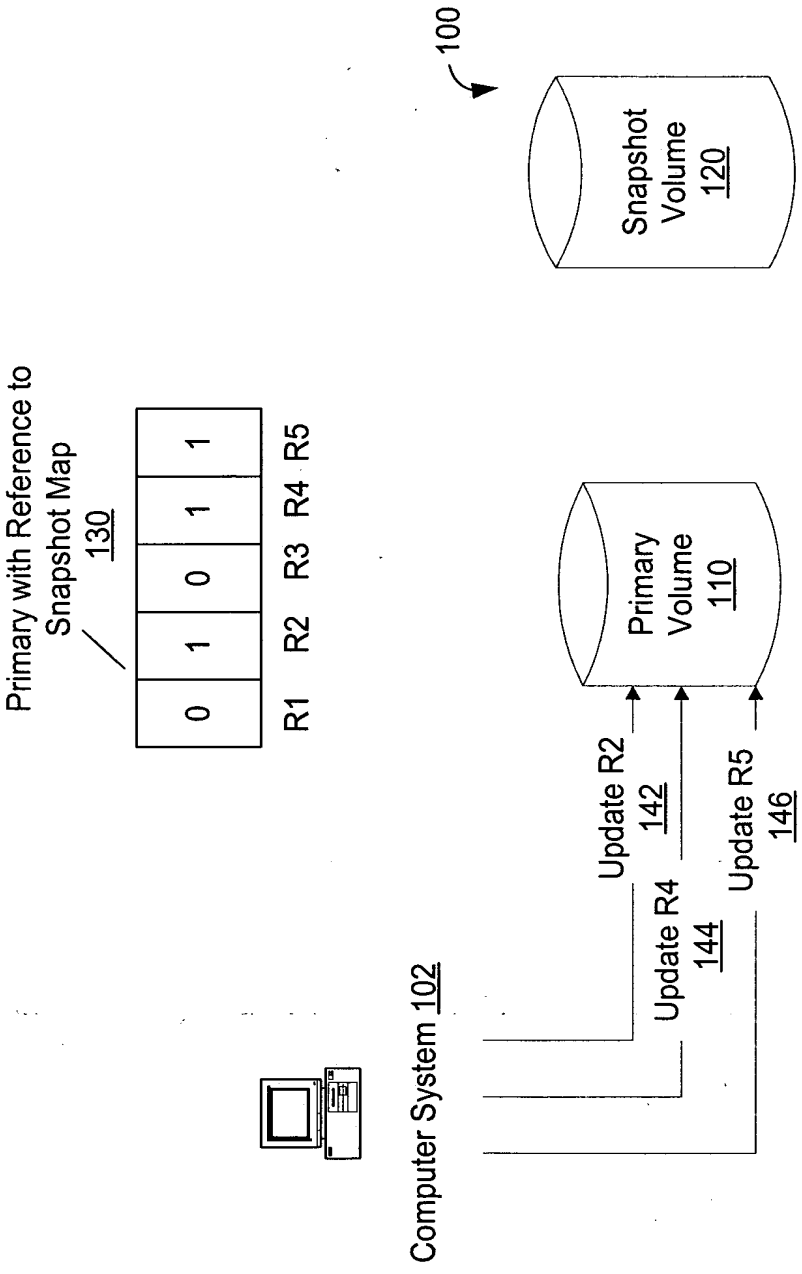
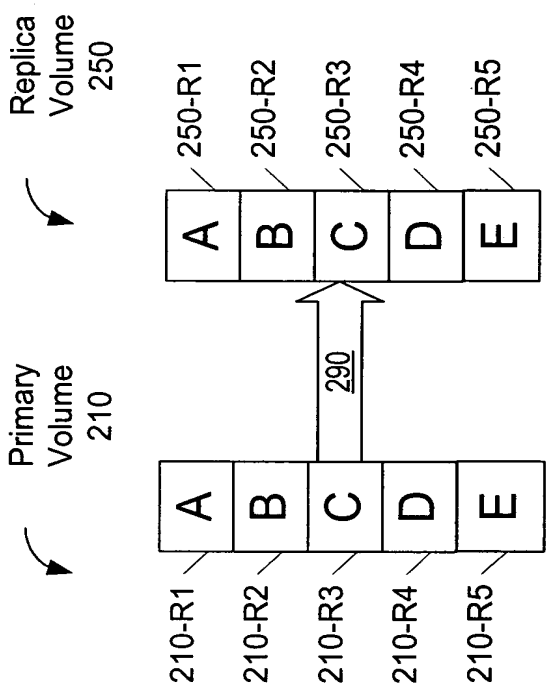

100
Snapshot Volume 120
Primary with Reference to Snapshot Map 130
0 1 0 1 1
R1 R2 R3 R4 R5
Primary Volume 110
Update R2 142
Update R4 144
Update R5 146
Computer System 102

FIG. 1



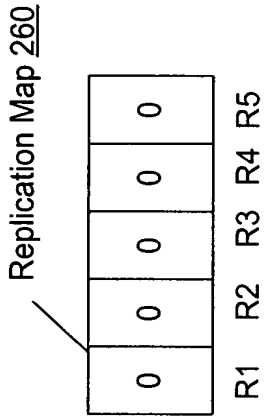


FIG. 2A
Synchronized

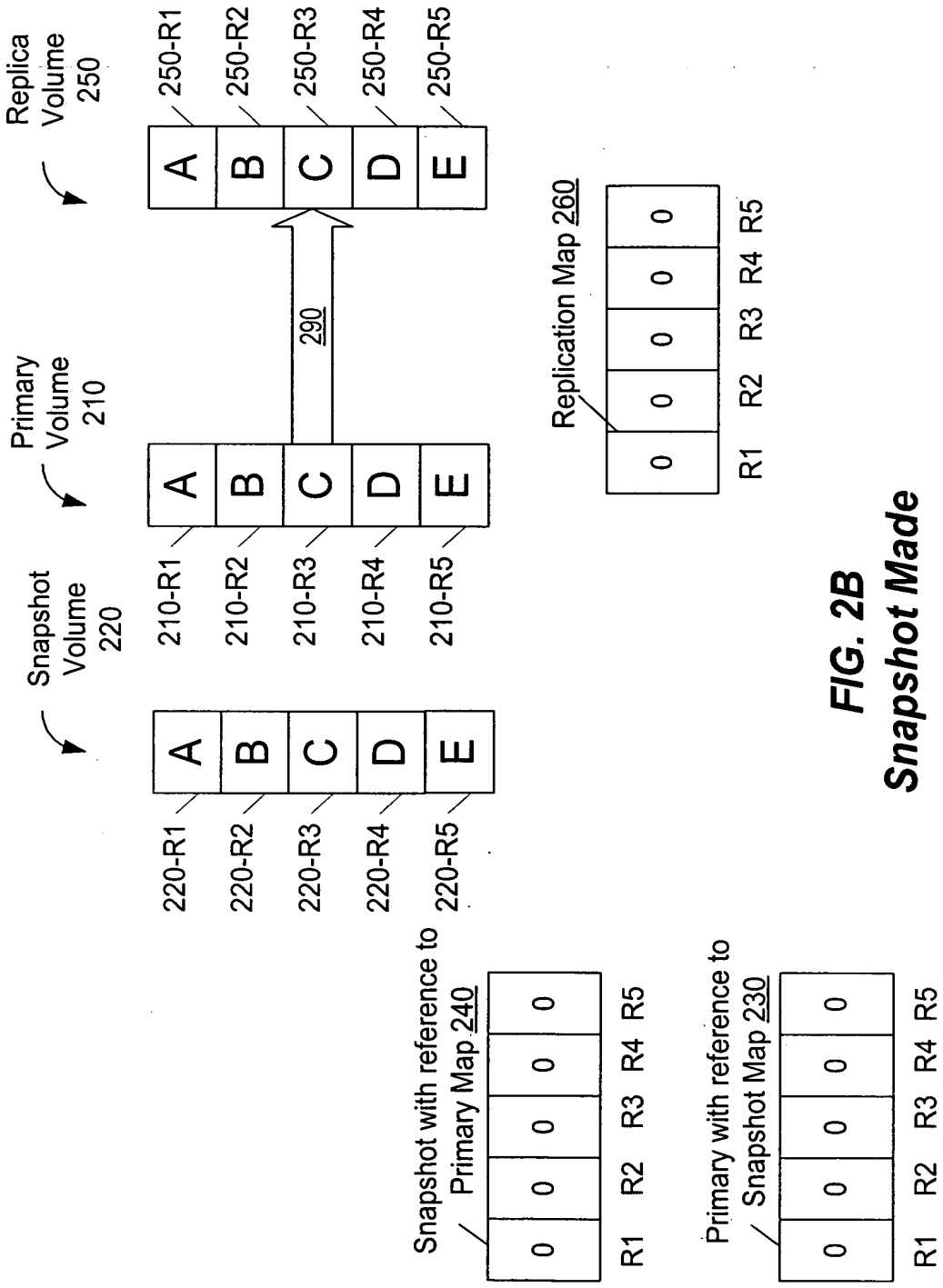


FIG. 2B
Snapshot Made

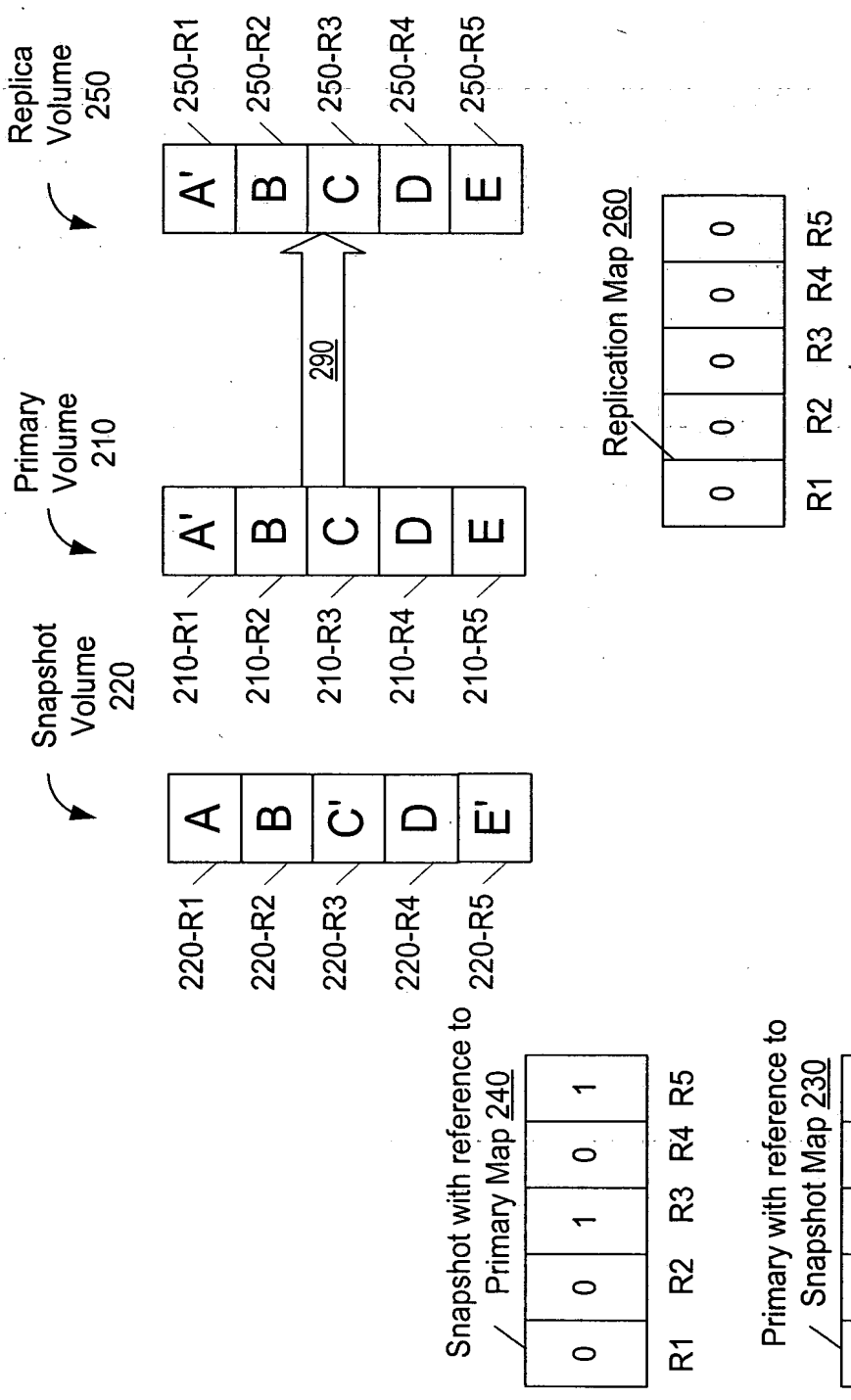


FIG. 2C
Updates To Primary Volume And Snapshot Volume

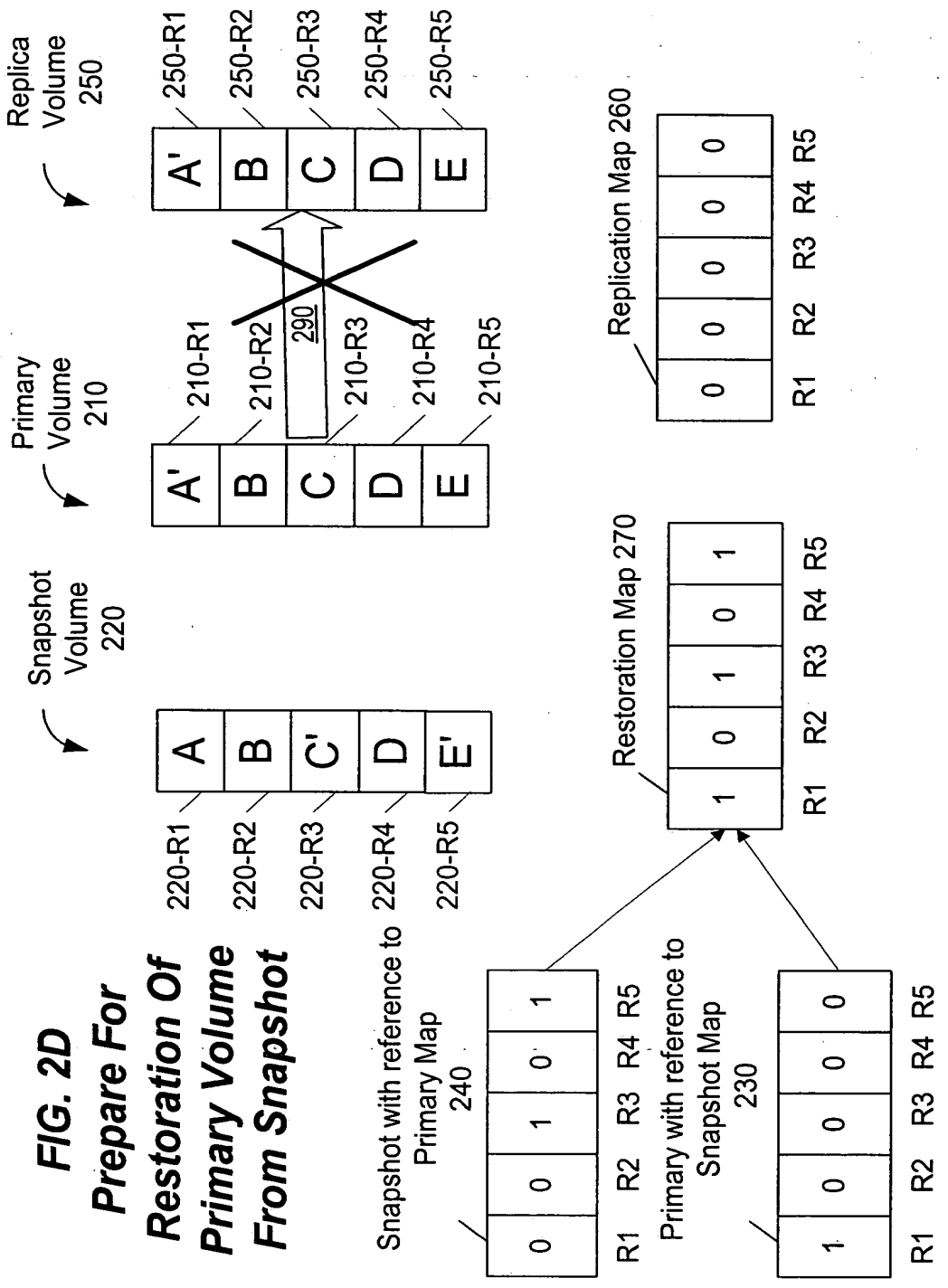


FIG. 2D
Prepare For Restoration Of Primary Volume From Snapshot

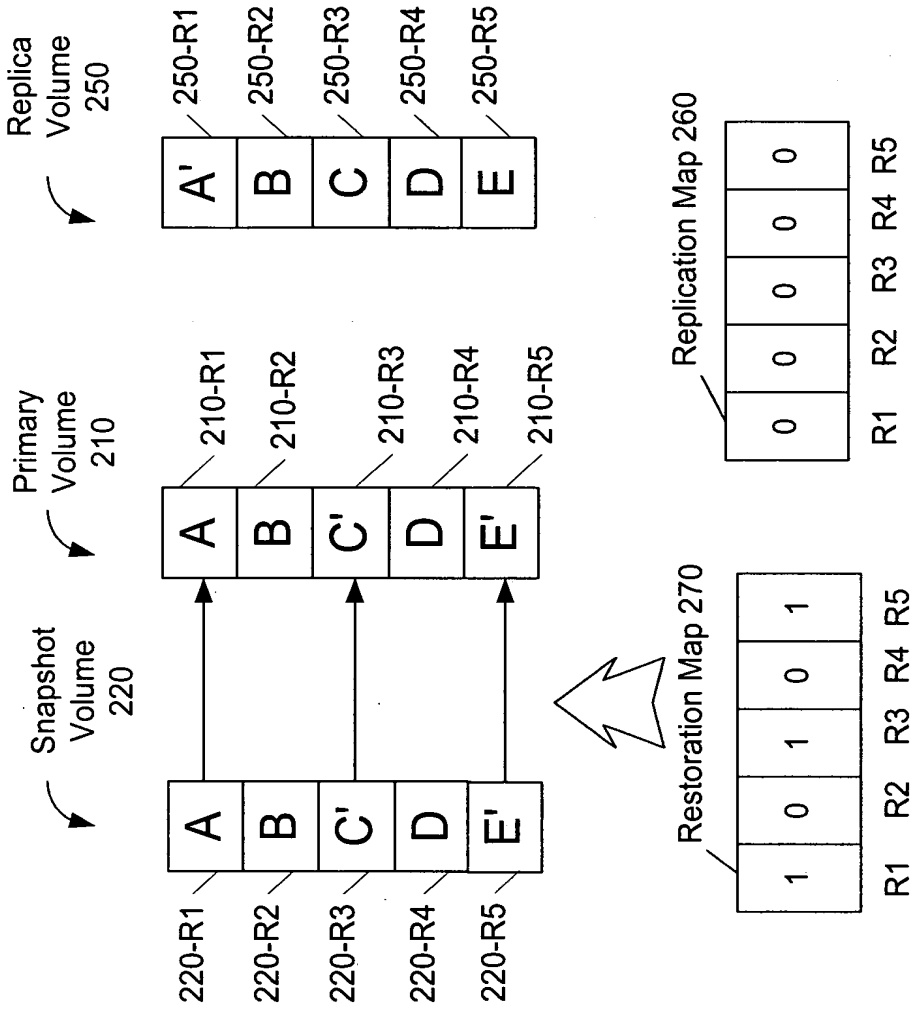


FIG. 2E
Restore Primary Volume From Snapshot

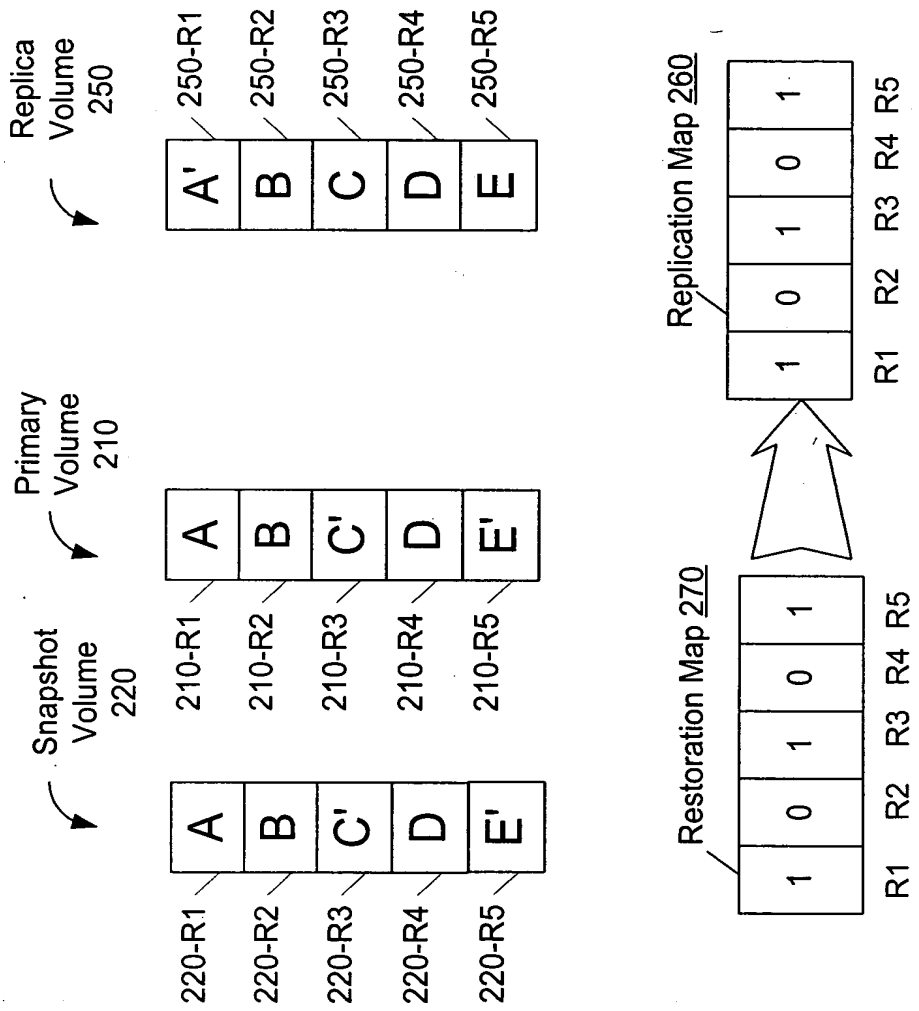


FIG. 2F
Initialize Replication Map

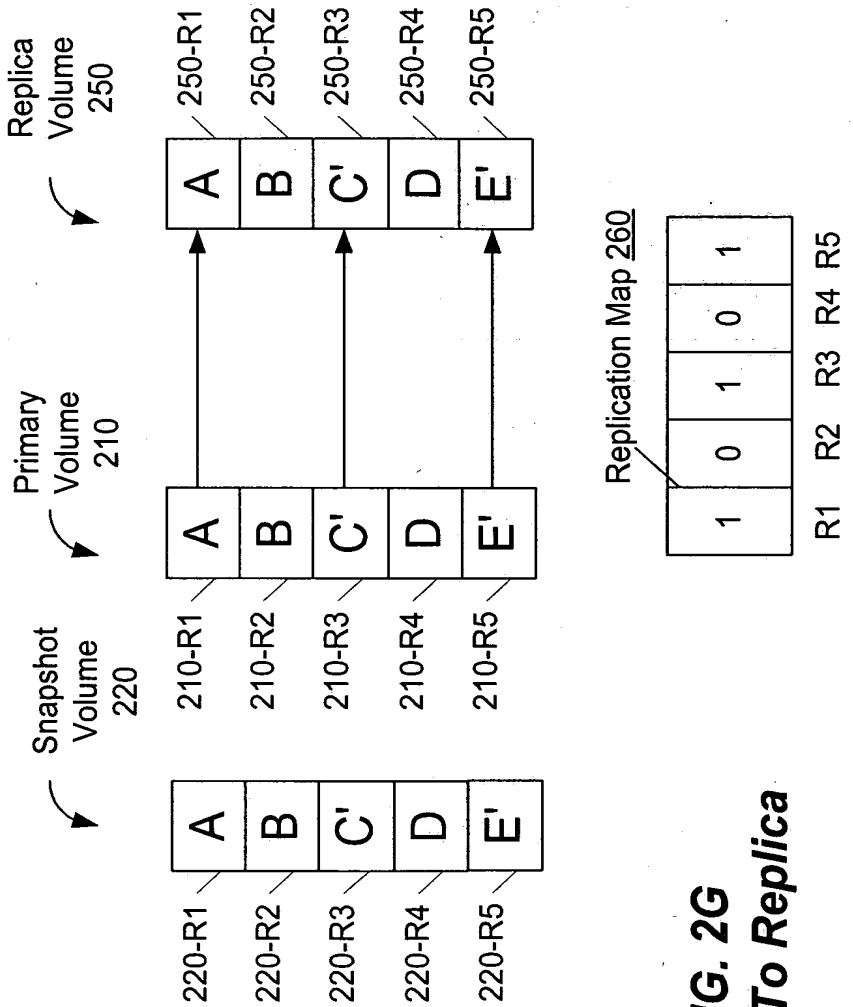


FIG. 2G
Copy To Replica

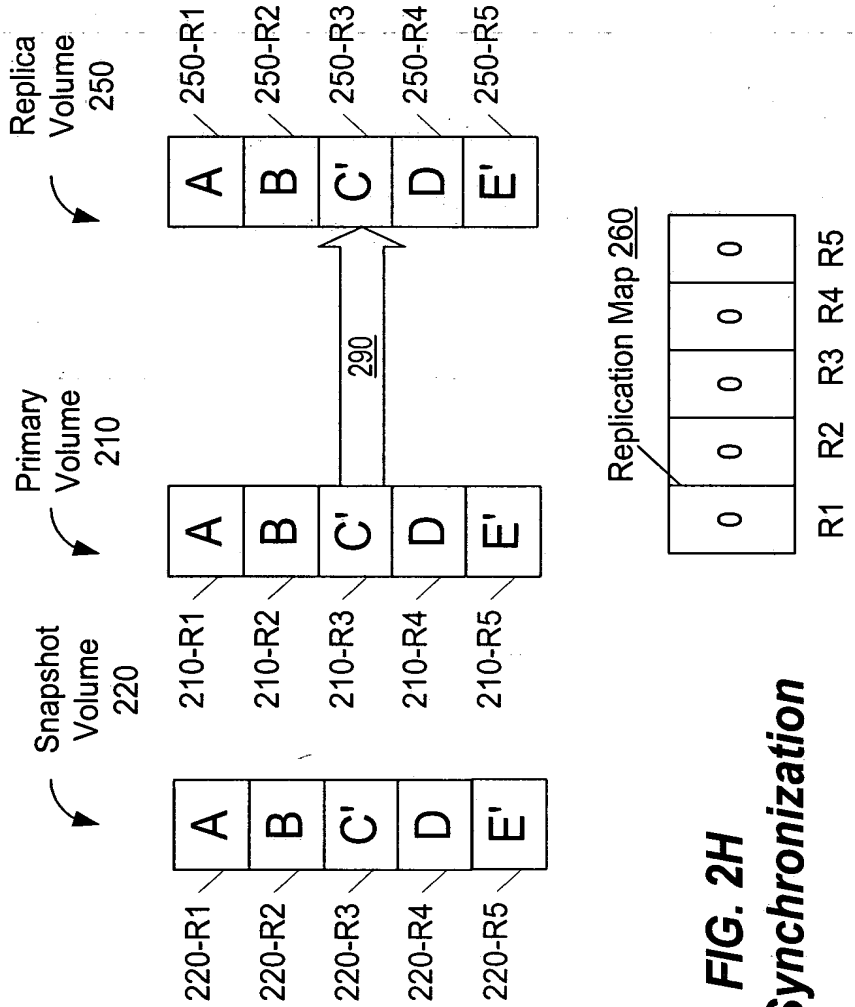


FIG. 2H
After Synchronization

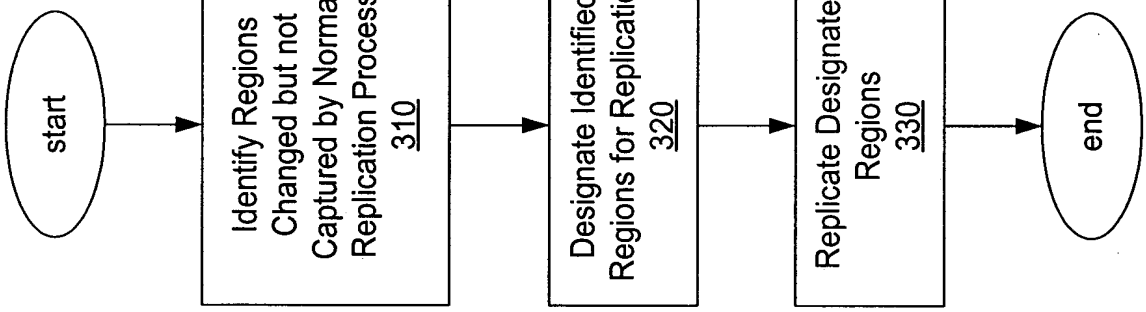

start
Identify Regions Changed but not Captured by Normal Replication Process 310
Designate Identified Regions for Replication 320
Replicate Designated Regions 330
end

FIG. 3

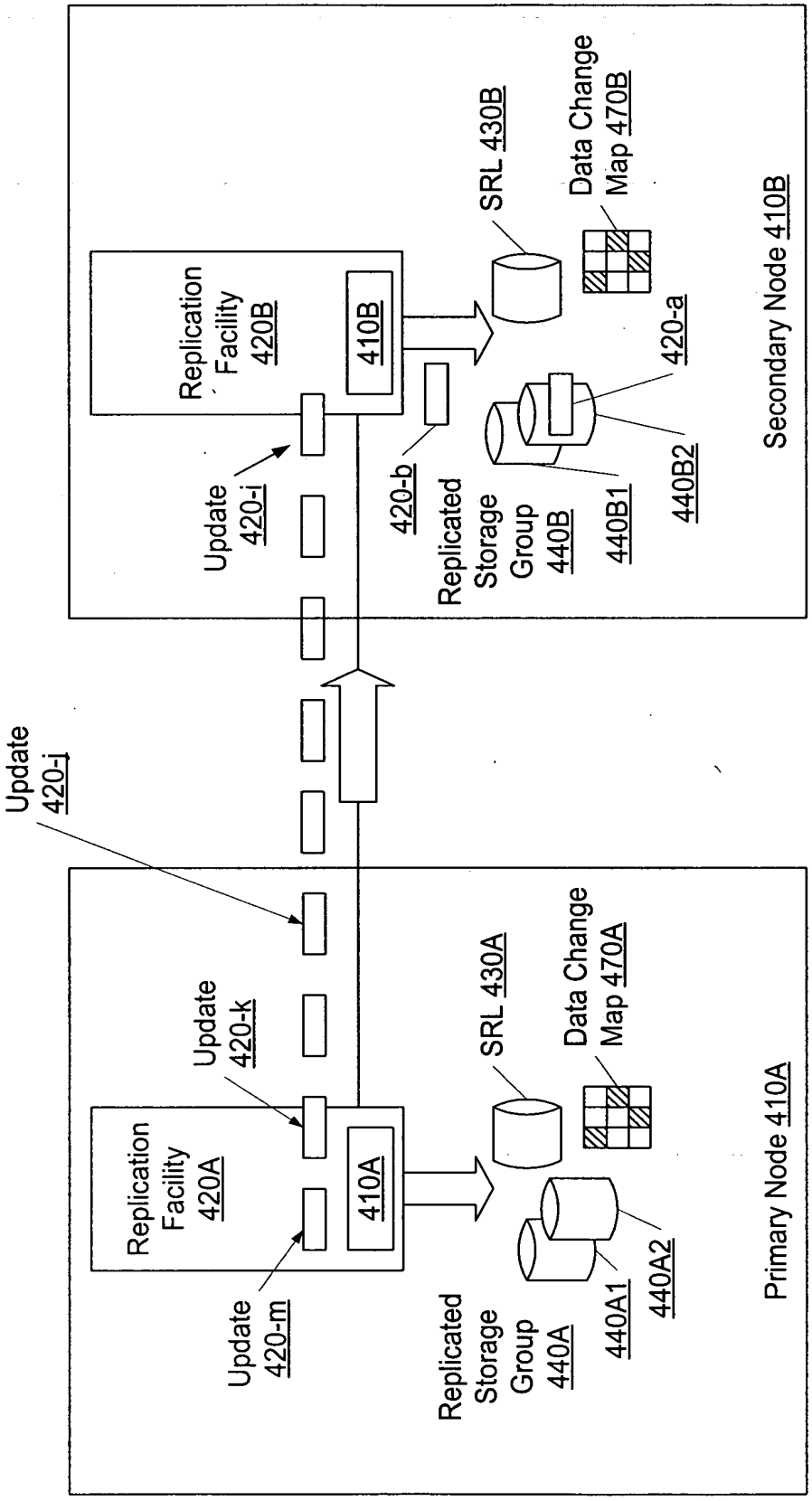

Update 420-j
Primary Node 410A
Replication Facility 420A
410A
Update 420-k
Update 420-m
SRL 430A
Data Change Map 470A
Replicated Storage Group 440A
440A1
440A2
Secondary Node 410B
Replication Facility 420B
410B
Update 420-i
420-b
SRL 430B
Data Change Map 470B
Replicated Storage Group 440B
440B1
440B2
420-a

FIG. 4

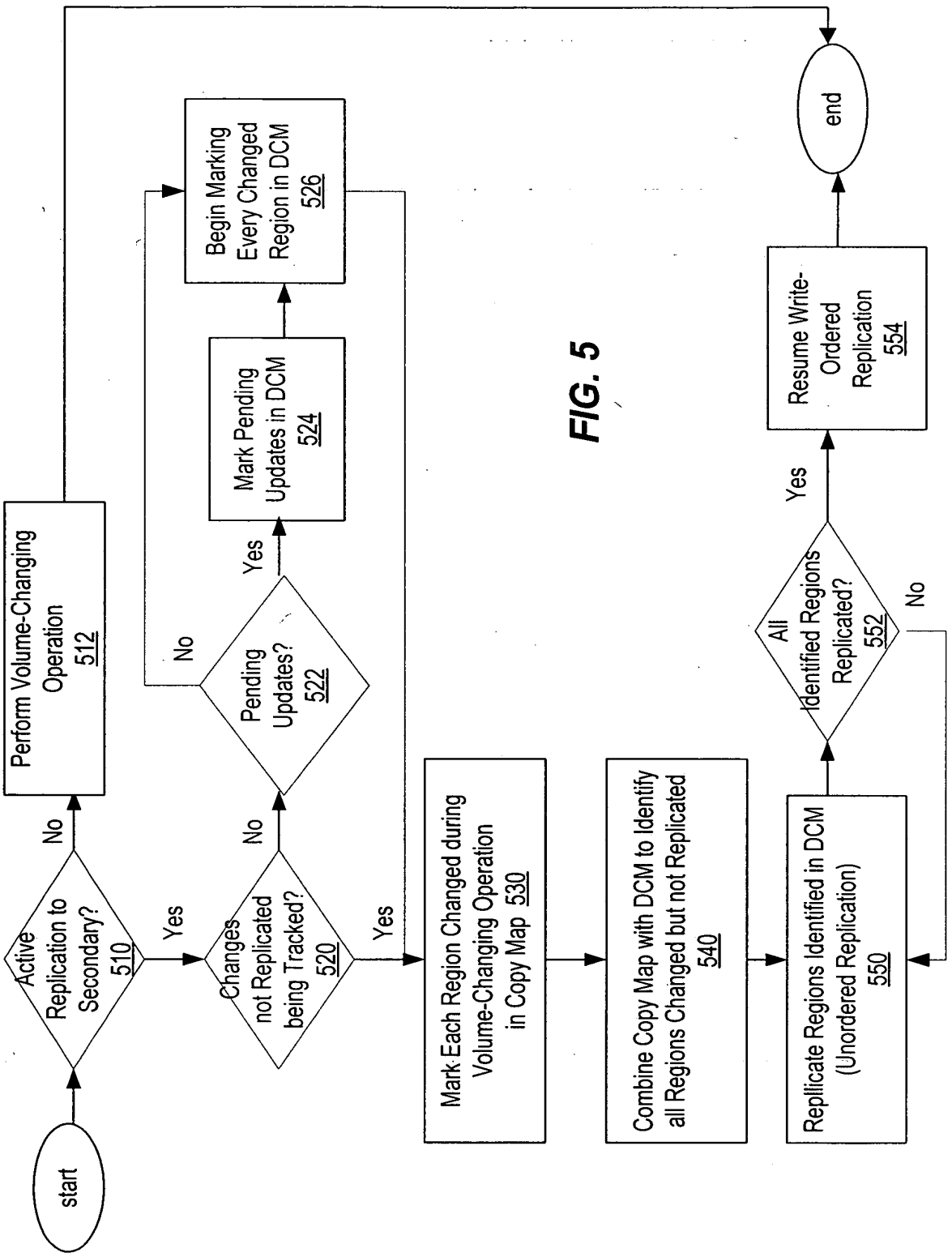

start
Active Replication to Secondary? 510
No
Yes
Perform Volume-Changing Operation 512
Changes not Replicated being Tracked? 520
No
Yes
Pending Updates? 522
No
Yes
Mark Pending Updates in DCM 524
Begin Marking Every Changed Region in DCM 526
Mark Each Region Changed during Volume-Changing Operation in Copy Map 530
Combine Copy Map with DCM to Identify all Regions Changed but not Replicated 540
Repllicate Regions Identified in DCM (Unordered Replication) 550
All Identified Regions Replicated? 552
No
Yes
Resume Write-Ordered Replication 554
end

FIG. 5

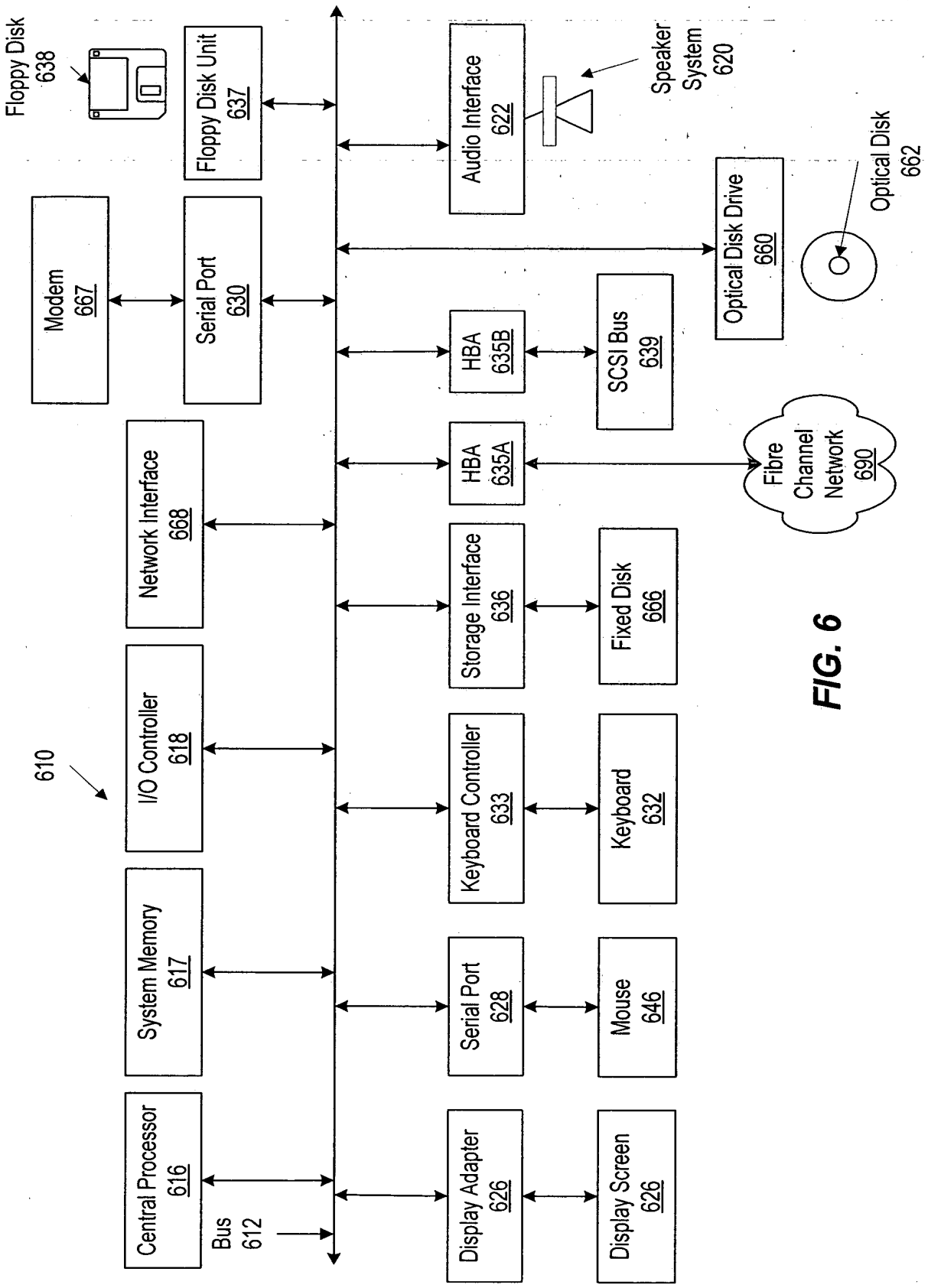

610
Central Processor 616
System Memory 617
I/O Controller 618
Network Interface 668
Modem 667
Serial Port 630
Floppy Disk 638
Floppy Disk Unit 637
Bus 612
Display Adapter 626
Display Screen 626
Serial Port 628
Mouse 646
Keyboard Controller 633
Keyboard 632
Storage Interface 636
Fixed Disk 666
HBA 635A
HBA 635B
SCSI Bus 639
Fibre Channel Network 690
Audio Interface 622
Speaker System 620
Optical Disk Drive 660
Optical Disk 662

FIG. 6

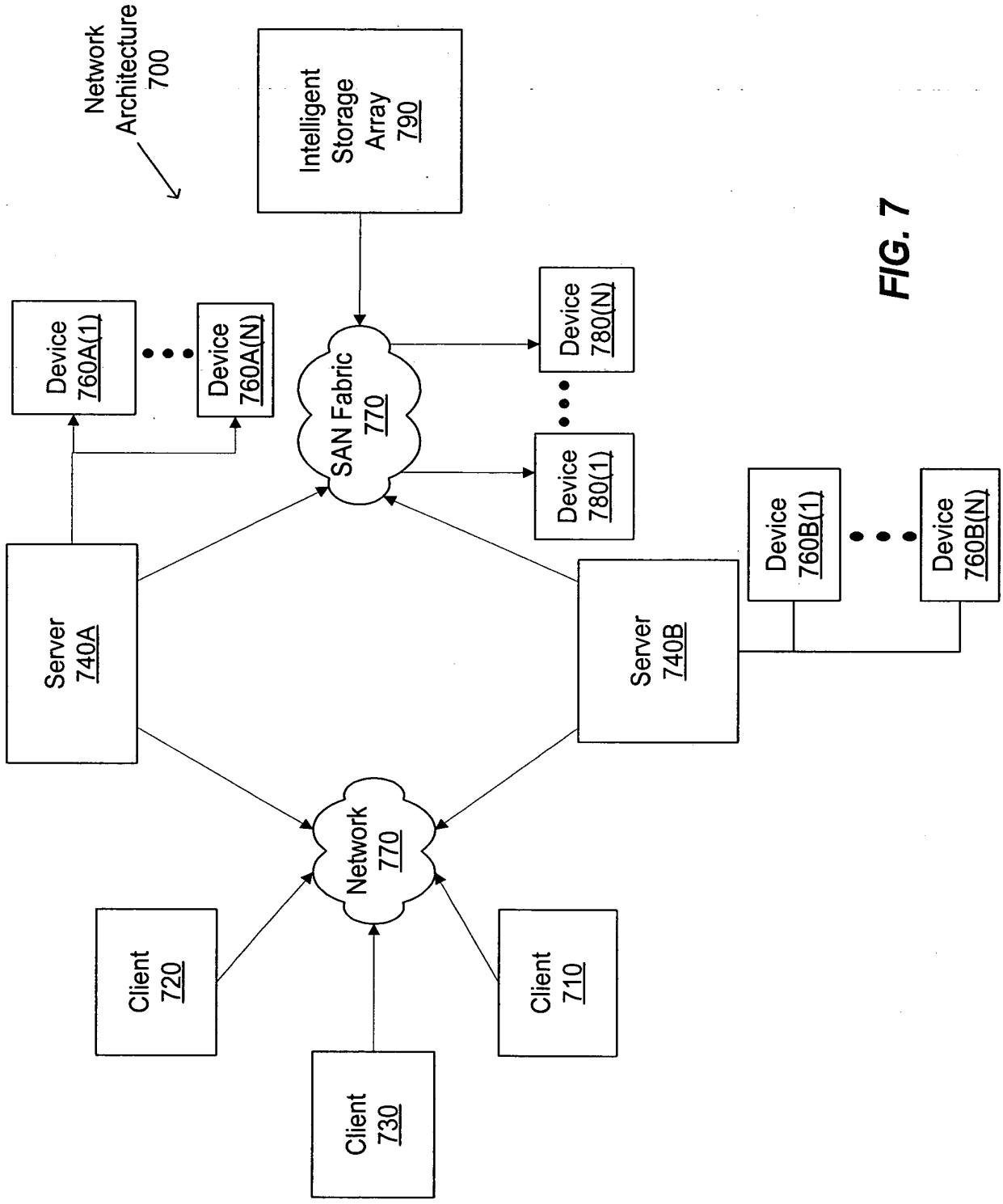

Network Architecture 700
Intelligent Storage Array 790
Device 760A(1)
Device 760A(N)
SAN Fabric 770
Device 780(N)
Device 780(1)
Server 740A
Server 740B
Device 760B(1)
Device 760B(N)
Network 770
Client 720
Client 710
Client 730

FIG. 7